The first commercial 3D laser scanners to capture detailed surface geometry of sites and large structures - such as buildings and industrial plants - debuted in the market in 1998. Some of these original developments are now in their fifth generation, while other new scanners have also since appeared. Today, almost all leading survey instrument manufacturers make laser scanners - thousands of scanners are in use every day and adoption is strong, with an estimated annual double-digit growth. Likewise, today almost all leading 3D CAD software vendors have some level of "point cloud" support. In many places and for many applications, terrestrial laser scanning is now mainstream.

Terrestrial laser scanner advancements
One of the reasons for strong adoption of laser scanners is continuous advancement. Overall, scanner advances have reduced laser scanning and training costs and have led to increasingly dense and informative scans. Several notable recent advances include:

- All-in-one design: scanner, power supply, control/display, data storage and digital camera in a single, compact, portable unit
- Standard survey workflow options: traverse, resection and back-sighting make scanning easier to learn and more efficient

Advances in terrestrial laser scanning are rapidly enabling adoption for 3D applications that were once considered interesting, but not practical or economic. Here's a look at how 3D terrestrial laser scanning is capturing the imagination of geospatial professionals and users.

A whole new world
• Reduced power consumption
• Faster scanning: Scanning now often takes just a few minutes per scan and has shorter set-up times
• Increasing “accuracy at range” and better ability to capture dark and oblique surfaces
• Reductions in scanner size, weight and price
• Improved accompanying digital imagery
• Many scanner accessories are now common items - survey controllers, total station batteries, tribrachs, iPads, etc.

Point cloud software for terrestrial scanning

While terrestrial laser scanners have noticeably improved, most users feel that the field side of scanning was already relatively simple and very fast. Rather, most users considered the main technology adoption barrier to be software and the office side. Large file sizes (easily into the GBs), plus the foreign nature of “working in 3D,” have long represented inherent challenges for transforming point cloud data into useful, actionable information.

Fortunately, recent advances on the software and workflow side have also reduced office processing costs and training costs - in many cases dramatically:
• Emergence of “panoramic scan images” as valuable, low-cost, scan-based client deliverables
• Quick-to-create ortho-images made of scan points
• Clients’ increasing, direct use of point clouds
• Increased automation
• 64-bit versions of point cloud software
• New scan data formats that speed working with large scan data files
• More point cloud plug-ins for CAD, such as for Revit
• Point cloud capabilities embedded directly within CAD applications

Also, not be underestimated, are increased office efficiencies that a growing army of laser scanner users gain over time.

Tipping point

At a conference in April 2012, I spoke with an owner of a small survey firm in the US. The conversation captured the essence of what today’s scanner and software advances mean to many geospatial professionals.

The owner first explained that he had gotten into laser scanning in 2005 with what were then a state-of-the-art, survey-grade scanner (introduced in 2003) and point cloud software. Over time, he used scanning on several projects where it was valuable. However, these were not common applications for his firm, so his scanner spent far more time in storage than originally hoped.

The owner then explained that at a laser scanning user conference in June 2011, he interacted with several successful scanner owners who had the latest generation (released in 2009) of the scanner he used and latest version of software. He decided to try out these latest tools. His trial went very well and he soon traded in his old scanner for the new version and updated his software.

When I spoke with the owner this April, he was glowing in excitement about his scanning tools and how they were benefiting his business. In a span of just a few months, the utilization of his new scanner was already well over 50% - a very healthy sign - and he was attracting new clients. He explained that his new scanner and office workflows for creating even standard survey deliverables were now so efficient that it simply cost less to do many of his common survey projects with scanning than to conduct them conventionally. The new scanner and software were also much easier for his staff to learn.

Accelerating market pull

The above discussion focuses on how costs have come down significantly for those who provide the service. Recent developments on the other side of the coin - the market pull for laser scanning - also paint a bright picture.

One big “pull” factor is the overall...
industry trend toward 3D - for design, visualisation, communications and even marketing. As leading CAD vendors heavily promote 3D, their customers listen intently. Two user presentations at the Hexagon 2012 conference in June really brought home this point. One was by a civil engineering firm that specialises in airport infrastructure design; the other was a civil engineering firm that specialises in septic system design.

Both presenters explained that their small companies had recently switched to 3D design and this, in turn, also prompted them to switch to laser scanning for their topographic and site survey needs. One reason was that 3D scans fit very effectively with their 3D design approach. In one case, the firm outsourced scanning services receiving registered 3D point clouds from their provider. In the other case, the firm acquired a 3D laser scanner, as they do more than 150 septic system projects each year. The firm also used their scanner - a versatile model - to develop new clients outside the septic business. This is a common scenario today: a company acquires a scanner to plug into their existing projects (doing them more efficiently) and then uses this same tool to help diversify their business.

**Clients “get it”**

The client base of laser scanning service providers - typically designers, contractors, architects, fabricators, and asset owner/operators - is rapidly expanding. For these clients, the rich, digital, 3D aspects of laser scanning and scanning’s fast, remote capture capability provide many value-added benefits over traditional surveying:

- **Safety**: Less exposure to hazardous locations and situations (e.g. busy roads, industrial plants, unstable terrain) when collecting data
- **For designers**: Better as-built information leads to better retrofit designs
- **For contractors**: Better retrofit designs, in turn, lead to smoother, lower cost construction projects; also, better project QA reduces projects risks
- **For owner/operators**: Smoother construction and fast, remote data collection mean less down-time for their infrastructure, building, site, and plant assets.

There are many symptoms of how the client community has strongly embraced the benefits of terrestrial laser scanning. One symptom is that clients are now requiring scanning for various types of projects and applications. Many transportation agencies, plant engineering firms, tunnelling contractors and car manufacturers have standardised on scanning for their requirements.

Another symptom of accelerating client demand is the rapid proliferation of portal services that feed panoramic scan images/data into multiple disciplines for a single project. Piping, structural, HVAC (heating, ventilation and air conditioning), mechanical, civil, equipment, electrical design and even safety and maintenance staff can all use the same rich scan data to extract information for their specific tasks. Portals quench this multi-discipline thirst for the same data by giving all staff ready access to laser scans (and associated imagery) via the internet and panoramic scan/image data sets.

**Rapidly emerging applications**

When scanning was first introduced,
vendors touted many interesting “potential applications.” Today, many of these are surging into their next level of adoption. Here are a few:

**Forensics** - Aided by today’s efficient, accurate tools and quick, easy-to-use deliverables, laser scan data has proven a big winner in the courts. Both prosecutors and defendants are rapidly switching to scanning as the ultimate truth of what a scene was like at the time of the incident - a scene they can view in 3D. Government agencies are buying scanners for multiple offices.

For example, UK agencies recently acquired more than 30 scanners for road incident management, timed around the 2012 Olympics. The California Highway Patrol has seven scanners for accident investigations.

**Heritage** - Recent growth in this segment is dramatic. In addition to restoration and refurbishment projects, scanning is now also being used for archive, education and site management. Entire organisations, like CyArk, have sprung up in this area and have already captured large numbers of important heritage sites around the world.

**BIM** - Building information modeling (BIM) is a very high growth application for scanning. Here, laser scans of existing buildings - interiors and exteriors - are used to help create 3D intelligent models. This approach is rapidly catching on with contractors and pulling lots of laser scanning with it, as scanning is often the best way to quickly capture buildings with sufficient 3D detail.

**Ships** - Used for ship modification projects in scanning’s early days, it has broken through into ship and rig building as well for construction and fabrication QA and detailed design.

**Fabrication and construction QA** - It has become common to find scanners in fabrication shops and yards capturing the detailed geometry of large complex objects, like piping spools or large equipment. Scans of an object in the fab shop are virtually fitted with scans of the site or structure where the fab shop structure is planned to be installed. This “virtual fit-up” process has caught many potentially costly mistakes early and allowed cost-effective fixes in the fab shop. The same applies to the use of scanning for construction QA of buildings. It is being increasingly used to check critical items, such as floor flatness and floor-to-floor utility alignments, before work proceeds to the next step. Scanning is also now being used to capture the geometry and location of objects before things are covered up, i.e. before concrete is poured and wall and ceiling surfaces are put in place.

**Conclusion**

Thanks to recent advances in laser scanners and laser scanning software, in many cases today it simply costs less to scan a site or structure and provide the needed deliverable than to use conventional methods. Combined with increasing client demand for terrestrial laser scanning based on its proven added-value benefits, scanning has become mainstream for many applications and is enjoying rapid adoption for other applications once considered interesting, but not yet practical or economic. These positive trends are expected to continue.

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